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ABSTRACT

To determine if computer technology could improve shipboard instruction and training, an Automated Shipboard Instruction and Management System (ASIMS) was used for computer managed instruction (CMI) about the USS GRIDLEY during 1975-76. ASIMS comprised a NOVA 1200 minicomputer with support peripherals, a Computer Integrated Instruction (CII) system in General Damage Control (GDC), and a Shipboard Training Administration System (STAS). CII GDC provided offline instruction integrated with online computer testing, diagnostics, and prescriptives. STAS provided a generalized File Management and Information Retrieval System (FMS) that facilitated control of shipboard files, records, and reports. Posttest scores indicated that graduates of the CMI course significantly outperformed groups trained under conventional shipboard methods. Results also showed that CMI is technically and operationally feasible aboard ship, and commercial, off-the-shelf minicomputer systems can support both a CMI capability and limited nontactical ADP functions. A cost-effectiveness study was beyond the scope of the project. Project and technical supports are listed, as are references. (Author/LLS)

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SHIPBOARD INSTRUCTION AND TRAINING MANAGEMENT WITH COMPUTER TECHNOLOGY: A PILOT APPLICATION

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To determine if computer technology could improve shipboard instruction and training, an Automated Shipboard Instruction and Management System (ASIMS) was used for computer-managed instruction (CMI) aboard USS GRIDLEY (CG 21) during 1975-77. ASIMS comprised a NOVA 1200 minicomputer with support peripherals, a Computer Integrated Instruction (CII) system in General Damage Control (GDC), and a Shipboard Training Administration System (STAS). CII GDC provided off-line instruction integrated with on-line computer testing, diagnostics, and prescriptives.

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STAS provided a generalized File Management and Information Retrieval System (FMS) that facilitated control of shipboard files, records, and reports. Posttest scores indicated that graduates of the CMI course significantly outperformed groups trained under conventional shipboard methods. CMI was proved technically and operationally feasible aboard ship and it was shown that commercial, off-the-shelf minicomputer systems can support both a CMI capability and limited nontactical ADP functions. A cost-effectiveness study was beyond the scope of the project.

FOREWORD

This advanced development effort was conducted between March 1976 and November 1978 in support of Navy Subproject Z0108-PN (Education and Training Development), Work Unit Z0108-PN.14B (Shipboard Computer-Supported Command Management and Readiness System). It was sponsored by the Chief of Naval Operations (OP-100). The overall objective of the subproject was to use computer technology to improve shipboard instruction and training administration.

In 1972, CNO (OP-91) (now COMNAVDAC), began a study aboard USS DAHLGREN (DLG 12) (now DDG 43) on the feasibility of using a minicomputer to support nontactical ADP functions aboard a small combat ship. A Data General Corporation NOVA 1200 minicomputer with support peripherals was installed in DAHLGREN in January 1973. In July 1973, NAVPERSRANDCEN was tasked by CNO (OP-099) (now a part of OP-01), to determine the feasibility of using a minicomputer system aboard combat ships for instruction and training administration and was, subsequently, invited by CNO (OP-91) to use the previously installed mincomputer system in DAHLGREN for this purpose. By January 1975, using contractor support, NAVPERSRANDCEN had developed and installed in DAHLGREN a Computer Integrated Instruction (CII) system in General Damage Control and a Shipboard Training Administration System (STAS). The development of CII and STAS are described in NPRDC Technical Reports 76-11 and 17.

The CNO (OP-91) study in DAHLGREN ended in mid-1975. The computer hardware and software were upgraded and transferred to USS GRIDLEY (CG 21) in March 1976. A Chief Data Processing Technician from NAVPERSRANDCEN was assigned to GRIDLEY to operate and manage the CII/STAS minicomputer system. This report describes the test and evaluation of CII and STAS as used by GRIDLEY.

Appreciation is expressed for the following contributions to the effort:

- Dr. David J. Chesler, who was responsible for the concept and development of CII and STAS, including contract negotiations and monitoring and physical installation of CII and STAS in both DAHLGREN and GRIDLEY.

- CNO (OP-91), now COMNAVDAC, for the procurement, installation, maintenance, and use of the NOVA 1200 minicomputer system in DAHLGREN and for the system's subsequent transfer to NAVPERSRANDCEN for use in GRIDLEY.

- COMNAVSURFPAC, for allowing three guided-missile cruisers to participate in the evaluation phase of CII and STAS.

- Crews of USS GRIDLEY (CG 21), USS ENGLAND (CG 22), and USS HALSEY (CG 23), who participated as members of either a CII demonstration or a comparison group.

- Officers and supervisors of GRIDLEY, who used the system and adapted CII and STAS into an effective instructional and managerial system. Special appreciation is given to CDR Kenneth Viafore for using STAS, and to CDR Joseph Lockett for arranging crew participation in CII.

- DPCS Roland R. Pharr and DP2 Raymond J. Haas, who operated the minicomputer system in GRIDLEY, acted as the ship's CII training supervisor for over 100 enrolled CII students, and developed the majority of the GRIDLEY STAS management applications.

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- CDR James Ryals and LCDR Charles Helsper, who provided project management and military liaison for NAVPERSRANDCEN between 1975 and 1976.

- CAPT James J. Clarkin, Commanding Officer, NAVPERSRANDCEN, between 1974 and 1978, who negotiated the use and transfer of the NOVA 1200 minicomputer system, arranged for the participation of GRIDLEY as a demonstration ship, acquired the DPC billet to operate the CII/STAS system in GRIDLEY, and provided support and encouragement.

JAMES F. KELLY, JR.
Commanding Officer

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Technical Director

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SUMMARY

Problem

Operational commitments and physical conditions aboard ship, both at sea and in port, pose a quantum increase in the complexity of the training problem. As a result, most shipboard training, especially that related to job proficiency, is on-the-job training (OJT). OJT is, essentially, learning by observing and doing. Efforts to adopt the more formal structured training techniques of shore technical schools aboard ship are repeatedly thwarted by lack of personnel, funds, experience, space, and time.

Objective

The objective of this research and development was to improve training and training management aboard a Navy combat ship without increasing the supervisory workload.

Approach

An Automatic Shipboard Instruction and Management System (ASIMS) was installed in USS GRIDLEY (CG 21) to determine if computer technology could improve shipboard instruction and training. ASIMS comprised a NOVA 1200 minicomputer with support peripherals, a modified computer managed instruction (CMI) system called Computer Integrated Instruction (CII) in General Damage Control (GDC), and a Shipboard Training Administration System (STAS) with a generalized File Management and Information Retrieval System (FMS). CII GDC provided off-line individualized instruction integrated with on-line computer testing and prescription. The STAS FMS provided a means to create, update, and retrieve data files for multiple shipboard records and reports.

A demonstration group of GRIDLEY personnel completed parts or all of the GDC course using CII, and three comparison groups from USS GRIDLEY, USS ENGLAND (CG 22), or USS HALSEY (CG 23) received traditional shipboard GDC training. Group performance test scores were statistically compared to determine significant effects of shipboard training, with and without CII. Additional data were obtained by comparing student progress rates during student- and command-managed periods. Ship-generated FMS applications were developed, put in practice, and evaluated. Total system usability and maintainability data were obtained from both officer and enlisted personnel using structured interviews and attitudinal questionnaires.

Findings

1. CII student throughput (system efficiency), as measured by course modules completed per month and by the number of students finishing the course, increased with an increase in command monitoring and automated administrative controls of student progress.

2. End-of-training mean test scores for the CII graduates were significantly higher than scores obtained by the comparison groups being taught by traditional shipboard methods.

3. GRIDLEY personnel developed and used 12 automated file management applications in areas of personnel administration, operations, material maintenance management, and supply, using STAS FMS. Each application met a specific shipboard management requirement and saved administrative time and labor over existing manual methods.

4. Student and supervisor attitudes towards the use and utility of the CII system were favorable. Supervisors and managers indicated that CII saved supervisory time.

5. The presence of at least one full-time system manager was required to operate the system and to function as a training official for the CII students.

6. Minicomputer system hardware, which used off-the-shelf commercial equipment, had an overall system reliability factor of .928 (approximately 7% downtime) while aboard a Navy ship. The system was evaluated over a period of approximately 18 months (32% underway time).

Conclusion

A minicomputer-based CMI system using individualized instructional techniques is technically and operationally feasible aboard a Navy ship. Specifically, this trial application determined that shipboard CMI can provide effective learning for at least one knowledge-area course (in this case, GDC). System efficiency (student throughput) was significantly enhanced and simplified when command monitoring and management of CMI student progress was aided by computer-generated reports and automated-tracking techniques. Supervisors reported that CMI provided more GDC training than in the past, without increasing the supervisory workload. A full-time CMI training official, however, was required to administer the CMI course.

An insufficient quantity of CRT video-display terminals (1) resulted in an upper limit in the rate of student throughput (about 280 course modules per month), and (2) prohibited the implementation of a shipwide personnel qualification-monitoring application. Whether the pilot CMI system could support multiple CMI courses without a degradation in system performance was not verified.

Also, it was demonstrated that a commercial, off-the-shelf minicomputer system can operate reliably at sea aboard a Navy ship and can support both a CMI capability and limited nontactical automated data processing (ADP) functions.

Recommendations

1. Shipboard CMI research and development should be integrated with the Navy's efforts to install minicomputers for nontactical ADP functions on combat ships during the 1980s.

2. The shipboard CMI system concept should be expanded beyond the pilot phase with state-of-the-art minicomputer hardware and software. The system's capability to manage more than one course (three or four) and to manage instruction of performance skills, as well as knowledge, should be tested in the shipboard environment.

3. A computer-integrated shipboard personnel-readiness and training-management system that can effectively plan and monitor all individual and shipwide training requirements should be developed, implemented, and tested in the shipboard environment.

4. A cost-effectiveness study should be conducted to determine the economic feasibility of a shipboard CMI system.

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Problem

Operational commitments and physical conditions aboard ship, both at sea and in port, pose a quantum increase in the complexity of the training problem (Main, Abrams, Chiles, Flaningam, & Vorce, 1978). For example, Main et al. (1978) reported that, even aboard the Navy's large aircraft carriers, there is little physical space for training and study in the formal sense. Compartments are crowded, noisy, hot, and, even under the best conditions in port, not conducive to study; at sea, work schedules, watches, and sea state give any form of training a low priority status. Exacerbating the training problems imposed by environment is the fact that ship manning does not provide the personnel with the professional training essential to develop instructional material and carry out formal training. Yet ships must perform a multitude of training evolutions with personnel generally inexperienced in instructional methods and techniques.

Because of these training problems, most shipboard training, especially that related to job proficiency, is on-the-job training (OJT). OJT is, essentially, learning by observing and doing. Efforts to adopt the more formal structured training techniques of shore technical schools aboard ship are repeatedly thwarted by lack of personnel, funds, experience, space, and time.

Background

In recent years, some effort has been made to solve the shipboard training problem by using computers to support personnel management, instruction, and training. In 1972, the Chief of Naval Operations (OP-91) (now Commander, Data Automation Command) began a study aboard USS DAHLGREN (DLG 12) (now DDG 43) to determine the feasibility of using a mini-computer to support nontactical automated data processing (ADP) functions aboard ship. In January 1973, a Data General Corporation NOVA 1200 minicomputer system with support peripherals was selected and installed aboard DAHLGREN. In July 1973, the Navy Personnel Research and Development Center (NAVPERSRANDCEN) was tasked by CNO (OP-099) (now a part of the OP-01 organization) to determine the feasibility of using a minicomputer system aboard combat ships for instruction and training administration. Subsequently, NAVPERSRANDCEN was invited by CNO (OP-91) to use the minicomputer system that had previously been installed on DAHLGREN for this purpose.

By January 1975, the Center, using contractor support, had developed and installed on DAHLGREN a modified computer managed instruction (CMI) system called Computer Integrated Instruction (CII) in General Damage Control (GDC) (Hoyt, Butler, & Hayward, 1975) and a computer-based Shipboard Training Administration System (STAS) (Hayward, Hay, & Jaffin, 1975). In mid-1975, the CNO (OP-91) study in DAHLGREN ended. Subsequently, the computer hardware and software were upgraded and transferred to USS GRIDLEY (CG 21). Also, a Chief Data Processing Technician (DPC) from NAVPERSRANDCEN was assigned to GRIDLEY to operate and manage the CII/STAS minicomputer system.

In 1975 a computer-supported training management system was used aboard USS KITTY HAWK (CV 63) to manage the qualifications of personnel in the ship's Engineering Department (Helsper & Delong, 1975). The project was terminated, however, before the system could be thoroughly operated when the computer was removed from the ship. Also in 1975, a remote CRT terminal was used with a timeshared printer aboard USS ENGLAND (CG 22) to manage the ship's force repair and training activities. This same computer was used to assist ENGLAND in preparing for underway refresher training and to manage off-ship formal training both during and after overhaul. Although this

application demonstrated the benefits of having a computer support shipboard training administration, the computer was not physically aboard the ship.

Objective

This report describes the test and evaluation (T&E) of the Automated Shipboard Instruction and Management System (ASIMS) aboard GRIDLEY. ASIMS consists of the NOVA 1200 minicomputer with support peripherals, the CII GDC, and STAS. The objective of this T&E was to improve training and training management aboard a Navy combat ship without increasing the supervisory workload. Subobjectives were to determine if:

1. CMI can provide effective training aboard ship.

2. The attitude of students, supervisors, and managers supports CMI aboard ship.

3. CMI can be integrated with data-management capability for training administration and other management information functions aboard ship.

4. CMI can be operated and logistically supported aboard ship.

METHOD

Research Design

An experimental design of a modified nonequivalent control group (Campbell & Stanley, 1966, p. 47) was used in this T&E since a major experimental control (random assignment of subjects to groups) could not be imposed on crew members of active Navy ships. The demonstration group was comprised of GRIDLEY personnel who received GDC training with CII. The comparison groups were personnel from GRIDLEY, ENGLAND, and USS HALSEY (CG 23) who received GDC training without CII. The participating ships were cruisers of the same class and manning complement, and personnel had similar backgrounds, job specialties, rates and ratings, and years of Navy experience. Although a major experimental control was not practicable, the research design did provide controls for sources of internal and external invalidity (Campbell & Stanley, 1966) and was amenable to analysis of covariance.

Automated Shipboard Instruction and Management System (ASIMS)

Hardware and Operating Software

The ASIMS aboard GRIDLEY consisted of the following hardware:

1. Data General Corporation NOVA 1200 central processing unit (CPU) with 32,000 words of core memory.

2. DIABLO moving-head disk system with 1.3 million words of mass storage.

3. Data General Corporation magnetic-cassette tape units (2) with 1.3 million words of mass storage.

4. TELETYPE control-console terminal and paper-tape reader/punch.

5. DATA PRODUCTS line printer (132 characters).

6. DATA PRODUCTS line printer (80 characters).

7. MOHAWK card reader (255 cards per minute).

8. INFOTON video display terminals (4).

The manufacturer's system-support software contained a modular, device-independent, multitask computer operating system. This software provided GRIDLEY with a distributed, interactive, and timesharing computer system capable of supporting both timeshare and batch operations. Higher-level languages used by the system included extended versions of BASIC, FORTRAN, and ALGOL. The operating system software, including file and commands necessary to operate the NOVA 1200 system, is described in detail in the manufacturer's operations and technical manuals (Appendix A).

The minicomputer, peripherals, and instructional materials were installed in compartment 05-90-0-Q, two decks above the bridge (see Figures 1 and 2).

Computer Integrated Instruction (CII)

As indicated previously, the shipboard Computer Integrated Instruction (CII) in General Damage Control (GDC) was developed and installed aboard DAHLGREN by January 1975 (Hoyt et al. 1975). It was installed aboard GRIDLEY in early 1976.

CII provided GDC off-line instruction integrated with on-line computer testing, diagnostics, and prescriptions. After GDS had been selected as the subject matter area because of its criticality to shipboard safety, CII lessons were developed for 8 of the 12 Personnel Qualification Standards-2 (PQS-2) modules from NAVEDTRA 43119-2A (see Figure 3). This CII PQS course provided approximately 24 hours of instruction, plus 6 hours of on-line testing at a video display terminal. Instruction was modularized, individualized, and self-paced. Media used included programmed texts, self-study guides, audio-visual instruction, and audio instruction. Automated reports were generated to monitor and manage student progress. The assigned Data Processing Technician, acting as the CII training official, enrolled and indoctrinated new students, issued lesson materials, scheduled CII testing appointments, and distributed student progress reports.

STAS File Management System

The most salient feature of the computer-based Shipboard Training Administration System (STAS) was the File Management and Information Retrieval system (FMS), which was tailored for the NOVA 1200 minicomputer (Hayward et al., 1975). FMS provided GRIDLEY with the capability of establishing and maintaining several management data bases and for generating formatted reports from these bases. FMS was written in BASIC and performed the following functions in an on-line mode via a video display terminal or teletype:

1. Created and defined new data files.
2. Added, altered, and deleted records from a file.
3. Located, sorted, merged, and counted records.
4. Generated and printed reports.
5. Queried the data base of any file.

The STAS FMS was structured for a main data base and two data subsets. As developed, the main data base can be either all the data elements contained in the general

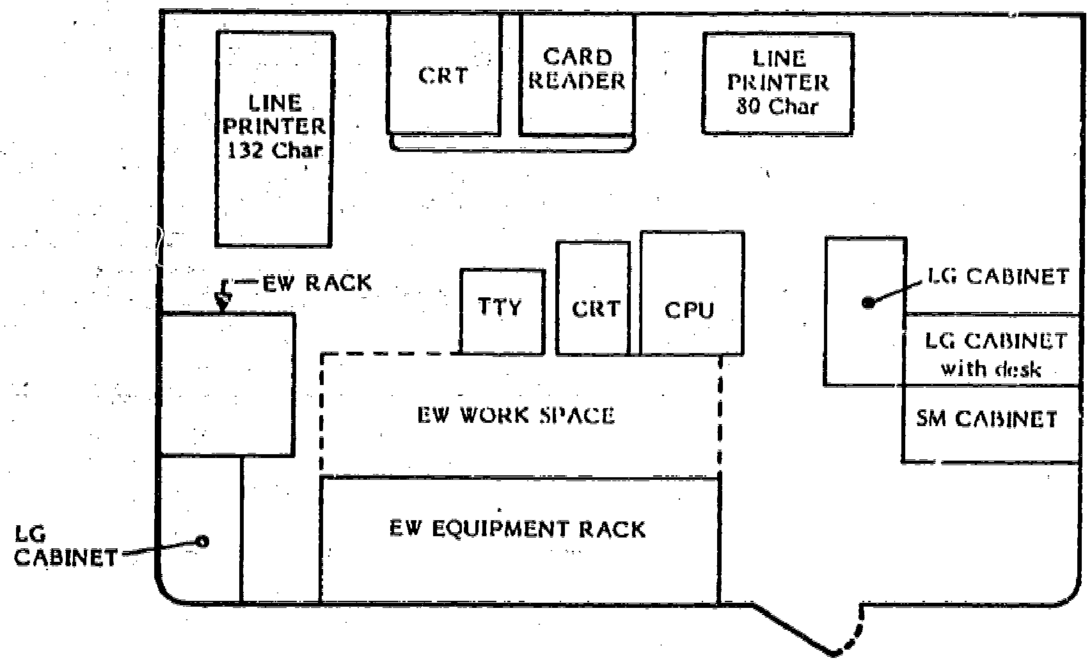

Figure 1. Shipboard Computer Room Compartment 05-90-0-Q.

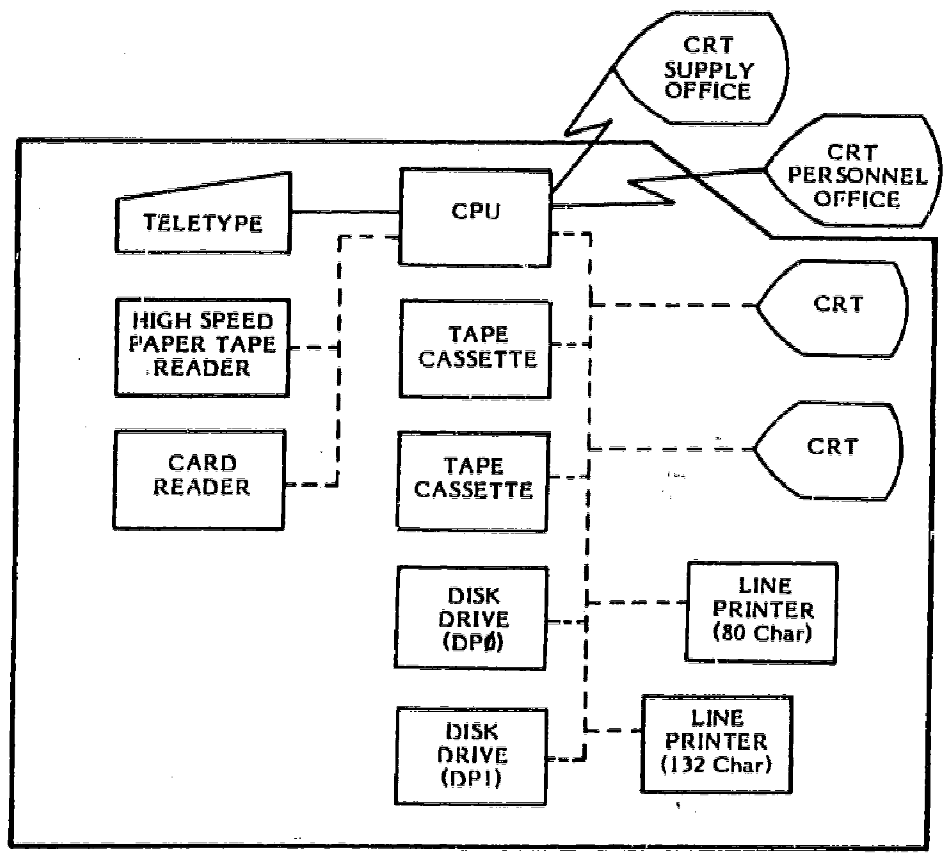

Figure 2. GRIDLEY minicomputer configuration.

2101 DAMAGE CONTROL—THEORY

Lesson 1--Compartmentation and Watertight Integrity (PI)
Lesson 2--Fire and Firefighting (PI)
Lesson 3--Battle Damage Types (PI)
Lesson 4--Battle Damage Repair (PI)

2102 NBC DEFENSE--THEORY

Self Study Guide

2103 FIRST AID AND RESCUE THEORY

No lesson material developed

2104 SAFETY PRECAUTIONS

Self Study Guide

2203 FIREMAIN SYSTEM

Lesson 1--Water Washdown System/Magazine Sprinkler System (PI)

2204 DRAINAGE SYSTEM

No lesson material developed

2205 VENTILATION SYSTEM

No lesson material developed

2206 FIXED DAMAGE CONTROL EQUIPMENT SYSTEM

Lesson 1--Fixed CO2 System (PI)
Lesson 2--Twin Agent Unit (PI)
Lesson 3--Twin Agent Unit (A/V)
Lesson 4--Twin Agent Unit (A)

2207 PORTABLE DAMAGE CONTROL EQUIPMENT SYSTEM

Lesson 1--Hoses, Nozzles, and Foam Equipment (A/V)
Lesson 2--Extinguishers (PI)
Lesson 3--Pump/Eductors (A/V)
Lesson 4--Blowers and Lanterns (PI)

2208 PERSONNEL PROTECTIVE EQUIPMENT SYSTEM

Lesson 1--Protective Clothing (A/V)
Lesson 2--Mark V Protective Mask (ND MK-V) (PI)
Lesson 3--Mark V Protective Mask (ND MK-V) (A)
Lesson 4--CO2 Inflatable Lifejacket (A/V)
Lesson 5--Casualty Dosimeter (DT-60/PD) (PI)
Lesson 6--Pocket Dosimeter (IM-143/PD) (PI)

2209 MECHANICAL FOAM/AQUEOUS FILM FORMING FOAM

Lesson material contained in 2206, Lessons 2, 3, and 4 on
Twin Agent Unit

2210 OXYGEN BREATHING APPARATUS (OBA) SYSTEM

Lesson 1--Oxygen Breathing Apparatus (OBA) Type A-3 (PI)
Lesson 2--Oxygen Breathing Apparatus (OBA) Type A-3 (A/V)
Lesson 3--Oxygen Breathing Apparatus (OBA) Type A-3 (A)

Figure 3. General damage control PQS-2 modules and CII lessons.

data base or the PQS data base. The general data base contains individual training information, including such data as rate, division, schools completed, and general military training status. The PQS data base is a complete record of the PQS program and the status of each individual aboard ship. The data subsets contain selected personnel and training information normally maintained by division officers.

Both the general and PQS data bases have dictionary files that contain specific descriptions (title, identification, characteristics, size, location) of the data base elements. Various preformated reports were made available with STAS, which integrated and tabulated selected data elements from the FMS data bases. The data elements included in the data bases and dictionary files are listed in Figure 4.

<table>
<tr><th>DICTIONARY DATA ELEMENTS--
STATIC DATA</th><th>GENERAL DATA BASE ELEMENTS--
DYNAMIC DATA</th></tr>
<tr><td>Expanded Element ID
Element ID
Element Length
Is This a String Element
Number of Elements in String
Which Record Contains Element
Element Starting Byte in Record

PQS DATA BASE ELEMENTS--
DYNAMIC DATA

Social Security Number
Name
Work Center
Completed QUAL cards (occurs 10 times)
QUALS in Progress (occurs 8 Times)
QUAL Number
Start Date
Total Possible Score
Cumulative Score
Completion Date
Required to Qualify</td><td>Social Security Number
Name
Last Update
Present Rate
Primary Navy Enlisted Classification (NEC)
Secondary NEC
Third NEC
Expiration of Active Obligated Service (EAOS)
Projected Rotation Date (PRD)
General Classification Test (GCT) Score
Arithmetic Reasoning Test (ARI) Score
Mechanical Aptitude Test (MECH) Score
Clerical Aptitude Test (CLER) Score
Divison
Pay Grade
Navy Service Schools Successfully Completed (occurs 6 times)
Navy Correspondence Courses Completed (occurs 10 times)
Course Code
General Military Training (GMT) (occurs 24 times)
GMT Code
Completion Date
Work Center
Completed QUAL Cards (occurs 10 times)
QUAL Number
Completion Date
CII Course Completed</td></tr>
</table>

Figure 4. STAS data base content.

Throughout the project, GRIDLEY managers were encouraged to use STAS and its FMS capability for any ADP application that they felt would improve general shipboard administration and management. NAVPERSRANDCEN assisted with this ADP expansion effort by providing system analysts, programmers, and technical writers.

Personnel and Logistic Support

System Manager and Operator. ASIMS was operated and managed by a Navy Chief Data Processing Technician, who provided the following functions:

1. Performed troubleshooting for both hardware and software.

2. Performed system analysis and programming required by management-information applications.

3. Operated all ASIMS equipment, created and debugged new computer programs, detected and patched program errors.

4. As the CII training official, (a) issued and maintained all CII lesson materials, (b) instructed each new student in the use of the CRT video display terminal, computer prescriptions for selection of remedial lessonware, and audio-visual equipment, and (c) printed and distributed student progress reports to the ship's supervisors.

5. Supported NAVPERSRANDCEN and GRIDLEY with system documentation and data base construction.

6. Trained system users on general FMS application data bases, report generation, and remote terminal operations.

Data-Entry Terminal Operators. GRIDLEY provided data-entry terminal operators for the department, division, or work center using and maintaining a file management application. These operators, of varying pay grades, could type and were usually assigned to the user work center. After approximately an hour of indoctrination, they could log-on the computer and enter the data. Seven shipboard personnel were engaged in data entry at the end of the evaluation period (e.g., a PNSN was assigned to enter data into the Personnel Record System (PRS) data base; and an SK3, to maintain the Supply Requisition Status data base).

Technical and Maintenance Support. The Data General Corporation provided technical and maintenance support throughout the period of the project, except for a 6-month period in 1976, when GRIDLEY was deployed to the Western Pacific.

Logistic Support. NAVPERSRANDCEN provided all funding, administrative, documentation, clerical, and ADP supplies, spare parts, system training, and all other logistic support necessary to operate the minicomputer facility aboard GRIDLEY.

Procedure

Pretest

All personnel reporting aboard GRIDLEY, HALSEY, or ENGLAND during the 14-month evaluation period (July 1976--August 1977) were pretested in GDC using a paper-and-pencil test. The test included 60 multiple-choice items, which had been developed from the Theory and System sections of the GDC/PQS (NAVEDTRA 43119-2A) and had been validated on damage control experts and novices (Hoyt et al., 1975). It was administered to groups of 30 to 50, either in port or at sea, or, in the case of persons

reporting aboard after the evaluation period began, when they arrived. Since the purpose of the pretest was to assess knowledge in GDC, all of the ships willingly participated in the testing to enhance their existing GDC training program.

During the evaluation period, the three ships participated in similar Eastern Pacific local operations, deployment build-up, and a Western Pacific deployment. There were no known operational incidences that would have adversely or favorably affected the execution of regular shipboard training on any of the three ships during this period.

By the end of the evaluation period, a total of 671 persons had taken the test--445 from GRIDLEY, 120 from HALSEY, and 106 from ENGLAND. In all cases, test results were analyzed and a diagnostic summary of GDC training weaknesses and strengths were provided to each ship. Participants, however, were not appraised of their test performance until after the experiment had been completed.

GDC Training

Subjects in GRIDLEY were told that they could use the shipboard CII system to prepare them to complete their GDC PQS. A detailed description of the CII instructional procedure is provided in Appendix B.

All subjects participated in regular shipboard training activities. Also, they participated in or were exposed to GDC-related lectures, films, and demonstrations required as part of the ships' regular training program. Although CII training was not given to the comparison groups, the GRIDLEY subjects who chose not to participate in the CII course were, nevertheless, exposed to it through living and working in close proximity to the CII students, lesson materials, and training equipment. Knowledge gained about GDC in this manner, however, was considered incidental.

It should be noted that, in ENGLAND, an instructor-managed instruction (IMI) version of the CII GDC course was conducted between September 1977 and April 1978 (after the CMI evaluation period) to ascertain if the project course material could be managed by existing ship personnel without the aid of a computer. Two graduates of the CII GDC course acted as course learning supervisors. Course administration duplicated most of the CII GDC functions but was accomplished by the two supervisors rather than the computer.

Student Versus Command Management

In any military course of instruction, student module or lesson completion rate generally can be influenced by both the amount of command pressure and the degree of attention given to student progress. In GRIDLEY, from July to December 1976, when the ship was deployed, the CII students were allowed to interact with the system at their own pace. To improve the flow of student through the course, the following changes were initiated in GRIDLEY in March 1977:

1. All persons who reported aboard GRIDLEY after March 1977 were required to take the GDC CII course as part of the GDC/PQS procedure. Also, students were encouraged to participate in the course during working hours. GRIDLEY's procedure for incorporating shipboard CII into the ship's GDC/PQS requirement is provided in Appendix C.

2. A CII testing appointment system was established. Computer printouts of student progress and lesson prescriptives were modified to instruct the student to make his next CII test appointment with the training official. Test appointments were logged

and could be made or changed by telephoning the computer center. Students were also instructed to contact their immediate superior concerning their next appointment and to brief him on course progress. The ship's Plan of the Day was also used to promulgate scheduled and available CII test appointments.

3. In each division, a Damage Control Petty Officer (DCPO) was designated to proctor and monitor student progress through the course and to act as a GDC/PQS qualifying petty officer for the division.

4. A CII Command Management Information System was inaugurated, and a computer-generated report itemizing student progress was promulgated weekly. The report, which was sorted according to department and division, listed those CII modules completed by each enrolled student, and showed the number of days the student had been in the course and since he had taken the last module test. If 7 days had elapsed since a student had last taken a test, the report flagged the individuals for division officer attention. A ship-wide summary report, which listed the total number of students enrolled, total number of modules completed in the previous week, etc., was made available to department heads, the executive officer, and the commanding officer.

Posttest

The posttest, the same test used for the pretest, was administered to participants from 9 to 12 months after they took the posttest. Of the original 671 testees, only 407 were available to take the posttest, due to discharge, transfer, or leave. Of this total, 258 were from GRIDLEY; 70, from HALSEY; and 78, from ENGLAND. On board GRIDLEY, 124 subjects had participated in the CII GDC course, and 134 had not.

A test-retest reliability coefficient was calculated for the GDC/PQS test with one of the comparison groups. This reliability was based on a mean test-retest interval of 164 days.

Data Collection

Questionnaire

GRIDLEY subjects who took the CII GDC course completed a questionnaire aimed at assessing the operational and support feasibility of CII GDC training. Students were asked to indicate the aspects of the course that they particularly liked; to note any problems that they experienced with the courseware, the computer, or other parts of the course; to rate the course in terms of instructional effectiveness; and to rate the importance of aspects of damage control. The questions asked are presented in Appendix D.

Interviews

On board GRIDLEY, interviews were held with ship's officers and supervisors, the CII training official, and CII students to determine (1) CII system utility in instruction and data management, (2) hardware operability, reliability, and maintainability at sea, (3) manning and personnel training requirements, and (4) logistic support requirements. Also, personnel on board GRIDLEY, HALSEY, and ENGLAND were interviewed to ascertain the quantity and quality of conventional shipboard training that occurred during the evaluation period.

Logs and Records

CII system operating logs, maintenance field service reports, training records, ships' operating schedules, and shipboard instructional materials were collected and analyzed.

RESULTS

Student Versus Command Management

Between July and December 1976, when GRIDLEY CII students managed their own progress through the CII GDC course, they either did not progress beyond the first or second modules or were very slow. By December 1976, only 8 of the 81 students who had been enrolled in the course had actually graduated--about a 10 percent completion rate. Students not only lacked incentive to complete the course, but also were not able to manage their own progress through the course (e.g., keeping CII testing appointments) because of the demands of shipboard-related duties. After March 1977, when course progress was directed by the command, both the number of modules completed and the number of graduates increased. It was considered that this increase was due primarily to the requirement that students use the CII GDC course to satisfy their GDC/PQS and the use of CII command management computer generated reports.

Table 1 provides the module completion rate during the student-managed and command-managed periods. During the third month of the command-managed period, when the students completed 259 CII modules, the CII system was becoming saturated. There appeared to be a limit to the number of modules the system could handle effectively each month. Since a completed module required a successful CII module-testing session (about 1 hour) with the computer, a maximum number of possible testing opportunities per month could be theoretically calculated. On the average, only about two CRT video display terminals were actually made available for on-line CII module testing. The other two terminals were either in an inoperative state or were dedicated to data entry for the various nontraining data management applications. Assuming two CRT terminals in which to administer CII module tests during a 7-hour work day, a 5-day work week, and a 4-week month, the maximum number of possible CII module test sessions available per month would be 2 x 7 x 5 x 4 = 280.

Table 1

Module Completion Rate--Student-Managed vs. Command-Managed Periods

Period	Modules Completed During Each Month						Total	Monthly Average	Percent Completed
	1	2	3	4	5	6			
Student-Managed 7/76-12/76 (N = 81)	15	26	34	13	41	29	158	26.3	24
Command-Managed 3/77-8/77 (N = 124)	83	246	259	170	62	52	872	145.3	88

Therefore, it became apparent that, even though various steps were taken in GRIDLEY to increase student flow through the CII system, there was a theoretical as well as a practical constraint on student throughput of about 280 testing sessions (or modules completed) per month. This constraint could be detrimental if there was a surge of new or delinquent students into the CII system.

CII Learning Effectiveness

At the end of the evaluation period, 54 GRIDLEY subjects had completed all of the 8 modules, 17 had completed 6 or 7, 18 had completed 4 or 5, and 35 had completed 1 to 3. Table 2 presents the pre- and posttest GDC scores for these groups, as well as for the comparison groups aboard GRIDLEY, HALSEY, and ENGLAND. As shown, the performance of CII graduates and of CII students completing from 4 to 7 modules was superior to that of other subjects.

Table 2

Pretest and Posttest Gains

Group	N	Pretest Means	Posttest Means	Gains
Demonstration--CII Graduates (GRIDLEY)	54	90.19	127.91	37.72
Demonstration--Completed 6 to 7 Modules (GRIDLEY)	17	83.18	106.36	23.18
Demonstration--Completed 4 to 5 Modules (GRIDLEY)	18	75.94	94.61	18.67
Comparison (ENGLAND)	78	84.20	97.67	13.47
Comparison (GRIDLEY)	134	81.93	91.81	9.88
Demonstration--Completed 1 to 3 Modules (GRIDLEY)	35	82.31	91.57	9.26
Comparison (HALSEY)	70	91.46	97.96	6.50

Note. The individual course modules were designed to be self-contained, could be taken in any order, and were assumed to be statistically independent.

To check for systematic differences between the seven groups in terms of posttest scores, while adjusting for the initial pretest differences, a 1 x 7 analysis of covariance was conducted, with pretest as the covariate. As shown in Table 3, the effects of the covariate and of the independent variable, student "Groups" with varying amounts of CII, were significant. As shown in Table 4, which provides adjusted group means of posttest scores, the CII graduates performed significantly better than did any of the other groups, as measured by the Duncan's Multiple Range Test ($p < .01$). Similarly, CII students completing 6 or 7 modules scored significantly better on the posttest than did the non-CII groups (GRIDLEY and HALSEY) and the CII students completing 1 to 3 modules.

Table 3

Analysis of Covariance for
Posttest Scores

Source	df	F
Groups (1-7)	6	22.19*
Covariate: Pretest	1	406.59*
Residual	398	

*$p < .001$.

Table 4

Adjusted Group Means of Posttest Scores

Group	N	Mean	Duncan Range*
Demonstration--CII Graduates (GRIDLEY)	54	124.33	
Demonstration--Completed 6 to 7 Modules (GRIDLEY)	17	107.54	
Demonstration--Completed 4 to 5 Modules (GRIDLEY)	18	100.72	
Comparison (ENGLAND)	78	98.72	
Comparison (GRIDLEY)	134	93.85	
Demonstration--Completed 1 to 3 Modules (GRIDLEY)	35	93.35	
Comparison (HALSEY)	70	93.51	

*$p < .01$ between bracketed groups.

Attitude Towards CII

Students

Results of the questionnaire administered to the 128 GRIDLEY CII students indicated that most of them liked computer testing, prescriptives, and progress reporting (Question 1, Appendix D). Sixty percent had no significant problem with the courseware (Question 2); and 58 percent, with the computer system (Question 3). Forty-seven percent said the major obstacle to completing the CII GDC training was shipboard duties (Question 4). The reading level, redundancy, and amount of detail in the instructional materials was reported to be about right.

Responses to Question 5 reveal that CII GDC trainees were not fully cognizant of the GDC/PQS organization or personnel aboard ship. Fifty-nine percent of the students felt that the CII GDC facilitated completion of the GDC theory and systems qualifications. In terms of importance of the GDC/PQS to study participants (Question 6), relatively equal importance was given to all facets of GDC training.

Command

Results of the interview with GRIDLEY managers and supervisors about CII indicated that:

1. The CII GDC course provided instruction that previously had been difficult to deliver because the ship lacked both instructors and time.

2. CII required less supervisory training time than conventional lecture-oriented training.

3. CII was effective, easy to use, and facilitated monitoring and controlling student CII throughput.

One annoyance cited by the GRIDLEY managers was that CII visibility caused by the computer-generated student progress reports diverted the attention of both command and students from other, perhaps more important, ship duties. Also, some supervisors felt that the CII GDC coverage was too extensive for shipboard training.

The students' tendency to escape ship's work for CII GDC instruction was effectively curbed by command intervention. CII activities were halted during fleet exercises or other demanding ship commitments, and were revived during slack periods in port or on transit.

GRIDLEY's commanding officer reported that the CII system functioned well and benefited the ship when the system was in a steady-state mode (about 50 to 70 1-hour testing sessions per week). If, however, a surge of new or delinquent students demanded more than 70 testing sessions a week, the system could not accommodate the extra requirement.

The executive officer asked if the system could accommodate more than one course at a time. Although it is possible to conduct several simultaneous courses by the system, such use was beyond the scope of this research. However, during the CII operation, it was observed that, when the computer was performing several functions simultaneously (giving CII tests, conducting a sort, or printing a report), the system slowed noticeably and

students often had to wait a minute or more for a computer response. If the system, with the existing hardware and software, had been required to administer multiple courses on a timeshare basis, the same degradation of response time would probably have occurred.

STAS FMS Applications

As indicated previously, the STAS File Management and Information Retrieval System (FMS) provided GRIDLEY with a versatile capability for establishing and maintaining several management data bases and for generating formatted reports from these bases. The primary computer applications used by GRIDLEY during the evaluation period are listed below:

1. File Management

2. Personnel Administration

   a. Personnel Record System (PRS)
   b. Public Affairs Officer File

3. CII Training Administration

4. Operations

   a. Employment Schedule
   b. Weapons Publication Inventory System
   c. CII Publication Inventory System
   d. Intelligence Publication Inventory System

5. Material Maintenance

   a. Deficiency Log
   b. IMA Job Status
   c. Preoverhaul Test and Inspection
   d. General Purpose Electronics Test Equipment (GPETE) Inventory and Calibration
   e. Gauge Calibration

6. Supply

   a. Material Requisition Status

The STAS general data base dealing with individual personnel and general training information (see Figure 4) was adapted by NAVPERSRANDCEN for the GRIDLEY Personnel Record System (PRS). The STAS PQS data base, which dealt with specific information on individual qualifications required by the PQS, was not used on GRIDLEY during the evaluation period because:

1. The ship lacked personnel and extra data-entry terminals necessary to maintain a shipwide PQS training data-management system.

2. The other nontraining FMS applications had a higher priority.

Appendix E provides a detailed description of the nontraining FMS applications. The data bases for these applications were developed and maintained by GRIDLEY personnel.

Hardware System Reliability and Maintainability

The overall equipment reliability factor for the computer hardware suit on GRIDLEY was .928, based on an evaluation period of 511 consecutive days. Equipment usage and casualty data were collected from system operating logs, maintenance field service reports, and system operator interviews. These data were used to assess individual component reliability factors. Table 5 lists these component reliabilities and provides the formula by which they were derived. Appendix F provides a detailed summary of the reliability and maintenance history of each ASIMS component.

Table 5

ASIMS Hardware Component Reliability

Component	Reliability Factor[a]
Line Printer (80 Character)	1.000
Card Reader	1.000
CRT Display Terminal #1	1.000
Disk Drive Unit #1	.998
CRT Display Terminal #2	.998
Disk Drive Unit #2	.954
Teletype Control Console	.951
CRT Display Terminal #3	.949
Central Processing Unit	.928
Cassette Tape Unit #1	.880
Line Printer (132 Character)	.820
CRT Display Terminal #4	.485
Cassette Tape Unit #2	.366

[a]The formula used to compute the reliability factor was

$$r_i = 1 - \frac{d_i}{D} = 1 - \frac{d_i}{511}$$

where r_i = component i reliability factor

d_i = number of days component i inoperative

D = number of days in evaluation period (i.e., D = 511)

Instructor-Managed Version of CII GDC Course

The following comments are made in regard to the instructor-managed instruction (IMI) version of the GDC course, which was evaluated between September 1977, when ENGLAND departed for a 6-month deployment to the Western Pacific, and April 1978. At the beginning of the evaluation period, the course was fully operational, with two course graduates acting as course learning supervisors for 30 students, all of whom had been pretested and had completed at least one course module.

1. In addition to the IMI GDC course, the crew participated in OJT GDC training throughout the evaluation period.

2. Course enrollment had increased from 30 to 78 between September 1977 and April 1978. However, 70 of the 78 students had completed none or only one module of the 8-module IMI GDC course over the 6-month period. Various divisions had been mass-tested on a module and personnel passing the module test were credited with passing that module. Although division personnel failing the test were expected to use the applicable IMI GDC course-module instructional material for remediation and retest, records revealed minimal module test retakes. Those who retook module tests seldom prepared themselves through course texts or training aids, but relied upon ship lectures, demonstrations, and peers.

3. The primary reasons cited by most IMI students and the IMI learning supervisors for the low course utilization were lack of incentive, lack of awareness, and poor accessibility of the IMI instructional materials.

4. During the evaluation, IMI students were not required to complete the IMI GDC course for satisfying GDC/PQS, and ship managers were not kept informed of student progress.

DISCUSSION AND CONCLUSIONS

This research has demonstrated that a computer can manage a general-purpose training course in the shipboard environment and can facilitate effective learning. Graduates of the CII GDC course aboard GRIDLEY demonstrated superior performance, based on end-of-training examinations, over groups trained through conventional shipboard methods. Even partial CII GDC training was effective.

CII student throughput, as measured by module completion rate, was found to be greatest when the ship supported the instructional system with direct individual assignment to the CII course, allocated time for training and testing during the regular working day routine, and distributed computer-generated student progress reports to ships' supervisors. The CII system hardware and software configuration, however, limited the rate of student throughput to about 280 modules per month, which meant a degradation in the computer management of individual students whenever a surge of new or delinquent students attempted to use the system and throughput was at or near its ceiling limit.

The overall attitude of shipboard personnel supported CII. Managers were sometimes concerned about students becoming overly involved with the CII system at the expense of other shipboard duties. The command, however, was able to regulate CII activity to periods when it did not conflict with ship commitments. The CII GDC course filled a training need that had not been met effectively in the past owing to lack of shipboard instructors. CII reduced the supervisory workload by eliminating lecture and examination preparation and delivery time. The IMI program, which used CII GDC course materials but was modified for manual administration, was not successful because it was not given full command support. Consequently, the supervisory workload of IMI and CII could not be compared. It was ascertained, however, that at least one full-time system manager was required to operate the CII system and to function as a training official for the CII students.

The CII off-the-shelf minicomputer system operated reliably at sea for an extended period of time. The system provided the ship with a capability to create and maintain a wide selection of nontactical ADP applications in the areas of personnel, maintenance, operations, and supply. In this administrative area, however, a training administration application, designed to monitor personnel qualifications and to maintain training history

data, was not evaluated because necessary data-entry personnel and terminals were not available.

The objective of the research, to improve training and training management aboard a Navy combat ship without increasing the ship's regular supervisory workload, was essentially met by applying computer technology and the techniques of computer-managed instruction. The research demonstrated that it was operationally and technically feasible to operate a computerized training system in a Navy ship and to provide for its logistic support.

Although the effectiveness of computerized training management was demonstrated, the economic feasibility of such a computer application was beyond the scope of this research. A comprehensive cost analysis of CMI in shipboard use would involve factors not considered in a research program limited to development and demonstration. For example, the CII minicomputer (1969 architecture) did not represent the most efficient state-of-the-art computer technology. To assess the cost-effectiveness of a system capable of managing multiple CMI courses and timesharing with nontactical applications, the latest state-of-the-art minicomputer or microprocessor is essential. The cost of such a computer system and the cost of a personnel support function to operate and maintain the equipment would influence the economic feasibility of CMI aboard ship.

RECOMMENDATIONS

1. Shipboard CMI research and development should be integrated with other Navy efforts to install minicomputers for nontactical ADP functions on combat ships during the 1980s.

2. The shipboard CMI system concept should be expanded beyond the pilot phase with state-of-the-art minicomputer hardware and software. The system's capability to manage more than one course of instruction (three or four) and to manage instruction involving performance skills, as well as knowledge of theory and systems, should then be tested in the shipboard environment.

3. A computer-integrated shipboard personnel readiness and training management system that can effectively plan and monitor all individual and ship-wide training requirements should be developed, implemented, and tested in the shipboard environment.

4. A cost-effectiveness study should be conducted to determine the economic feasibility of a shipboard CMI system.

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APPENDIX A

LIST OF PROJECT ADP AND TECHNICAL SUPPORT DOCUMENTS

ERIC Full Text Provided by ERIC

LIST OF PROJECT ADP AND TECHNICAL SUPPORT DOCUMENTS

Automated Data System Documentation Standards (SECNAVINST 5233.1A). Department of the Navy, 20 June 1973.

Automated Data Systems Documentation Standard Manual (DoD Manual 4120.17-M). Department of Defense, December 1973.

Automated Shipboard Information Management System (ASIMS), USS GRIDLEY, System Manual (GRIDLEY INST 5233.1). USS GRIDLEY (CG 21), 15 June 1976.

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Computer Integrated Instruction, General Damage Control Learning Objectives (NPRDC Tech. Note TDP 43-03.P14X1, TN-01A). San Diego: Navy Personnel Research and Development Center, July 1974.

Computer Integrated Instruction, General Damage Control Module Specifications (NPRDC Tech. Note TDP 43-03.P14X1, TN-02). San Diego: Navy Personnel Research and Development Center, April 1974.

DLG ADP Command/Management System, USS DAHLGREN, Systems Manual. Santa Monica, CA: Systems Development Corporation, March 1973.

Extended ALGOL User's Manual (DGC 093-000052). Southboro, MA: Data General Corporation, February 1975.

Extended BASIC User's Manual (DGC 093-000065). Southboro, MA: Data General Corporation, February 1975.

FORTRAN Commercial Subroutine Package (DGC 093-000107). Southboro, MA: Data General Corporation, February 1975.

FORTRAN IV User's Manual (DGC 093-000053). Southboro, MA: Data General Corporation, February 1975.

Fundamentals of Minicomputer Programming (DGC 093-000090). Southboro, MA: Data General Corporation, February 1975.

INFOTON Technical User's Manual for Vista Basic and Standard Video Display Terminal (INFOTON Manual WO 00744). Burlington, MA: INFOTON Incorporated, February 1972.

Introduction to Programming the NOVA Computers (DGC 093-000067). Southboro, MA: Data General Corporation, February 1975.

Introduction to the Real Time Disk Operating System (DGC 093-000083). Southboro, MA: Data General Corporation, February 1975.

Maintenance Instruction, Vista Standard (INFOTON Manual No. 00796). Burlington, MA: INFOTON Incorporated, January 1972.

Real Time Disk Operating System Reference Manual (DGC 093 000075). Southboro, MA: Data General Corporation, February 1975.

Real Time Disk Operating System (RDOS) User's Manual (DGC 093-000075-02). Southboro, MA: Data General Corporation, May 1973.

Shipboard Computer Integrated Instruction, Computer Operation Manual (NPRDC Tech. Note TDP 43-03.P14X1, OM-02). San Diego: Navy Personnel Research and Development Center, November 1974.

Shipboard Computer Integrated Instruction, Functional Description (NPRDC Tech. Note TDP 43-03.P14X1, PD-02A). San Diego: Navy Personnel Research and Development Center, August 1974.

Shipboard Computer Integrated Instruction, Program Maintenance Manual (NPRDC Tech. Note TDP 43-03.P14X1, MM-02). San Diego: Navy Personnel Research and Development Center, December 1974.

Shipboard Computer Integrated Instruction Test and Implementation Plan (NPRDC Tech. Note TDP 43-03.P14X1, PT-02). San Diego: Navy Personnel Research and Development Center, November 1974.

Shipboard Computer Integrated Instruction, User's Manual (NPRDC Tech. Note TDP 43-03.P14X1, UM-02). San Diego: Navy Personnel Research and Development Center, November 1974.

Shipboard Training Administration System Computer Operation Manual (NPRDC Tech. Note TDP 43-03.P14X1, OM-01). San Diego: Navy Personnel Research and Development Center, November 1974.

Shipboard Training Administration System, Data Requirements (NPRDC Tech. Note TDP 43-03.PX1, RD-01B). San Diego: Navy Personnel Research and Development Center, May 1974.

Shipboard Training Administration System, Functional Description (NPRDC Tech. Note TDP 43-03.P14X1, FD-01A). San Diego: Navy Personnel Research and Development Center, June 1974.

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APPENDIX B

CII INSTRUCTIONAL PROCEDURE

ERIC

CII INSTRUCTIONAL PROCEDURE

The student was issued an introductory booklet at the start of the course that explained the organization of the course, how to use the video-display terminal, and off-line course material. The student began his study by selecting any one of the eight modules developed specifically for CII from the 12-module General Damage Control PQS (see Figure 3 in text).

When CII processing was initiated, the display shown in Figure B-1 would appear on the video-display terminal CRT. At this point, the student could select any one of the three commands at his disposal.

```
                CII EXAMINATION GENERAL DAMAGE CONTROL USS GRIDLEY

     THE FOLLOWING EXAMINATIONS YOU ARE ABOUT TO TAKE RELATE TO YOUR CONTINUING
  PROGRESS IN MASTERY OF GENERAL DAMAGE CONTROL FOR USS GRIDLEY.

    YOU MAY NOW:

          1.  CHECK YOUR STATUS          (TYPE DISP)
          2.  TAKE A TEST                (TYPE EXAM)
          3.  TO LOGOUT                  (TYPE BYE)

    COMMAND?
```

Figure B-1. CII user control commands.

If he selected "DISP," a display of his current CII status would appear on the screen. Figure B-2 is an example of a record display for a student who had completed three CII modules.

```
123-45-6789      FRANKLIN D. JONES

MODNO   POS   PASS   SCORE   SDAT        CDAT      PRESCRIPTIVES - MODULE 6
    1    52     42      44   741111      741113    2207:1:HNF      2207:1:HNF
    2    29     23                                 2207:1:HNF      2207:1:HNF
    3    13     10      10   741115      741115    2207:2:81       2207:2:9-14
    4     5      4
    5    43     34
    6    62     50      56   741117      741117
    7    43     43
    8    44     33

PQS     POS   CUM
2101     10     8
2102     20
2103     20
2104     15    15
2201     10
2202     10
2203     10
2204      5
2205     10
2206     15    12
2207     15
2208     20
2209     10
2210     10
2301    101
```

Figure B-2. Standardized CII student record display.

If the student selected "EXAM," a shopping list of CII-module examinations would appear on the screen (Figure B-3). If he selected "BYE," he would be automatically logged off the system.

```
FROM THE FOLLOWING LIST SELECT THE NEXT CII GDC MODULE YOU
WISH TO TAKE.  IF THIS IS A NEW MODULE, YOU WILL BE GIVEN A
PRETEST.  IF YOU ARE WORKING ON A POSTTEST, IT MUST BE COMPLETED
AND IS SHOWN BELOW.

  1.  2101
  2.  2102
  3.  2104
  4.  2203
  5.  2206
  6.  2207
  7.  2208
  8.  2210

ENTER TEST NO. 1-8.
```

Figure B-3. CII user control "shopping list."

After the student selected the specific module he wished to study, he remained with that module until he had completed it. A pretest, taken once, was required for all modules. The pretest questions began with an identification of the module selected. The questions were displayed one at a time on the screen and remained displayed until an answer was entered by the student. An example question as it would appear on the screen is shown in Figure B-4.

```
          GENERAL DAMAGE CONTROL - USS GRIDLEY
               MODULE 1 - 2101 PRETEST

1.  WHAT ARE THE THREE MATERIAL CONDITIONS OF READINESS?
    (SELECT THE LETTERS)

    A.  WILLIAM
    B.  ZEBRA
    C.  YANKEE
    D.  XRAY
    E.  RED
    F.  ZULU
    G.  YOKE

    YOUR ANSWER IS?
```

Figure B-4. CII question format.

When the test was completed, the results were displayed immediately. If the student passed (Figure B-5), he received credit for the module and could proceed to the next module without taking a posttest.

```
MODULE TEST COMPLETED

POSSIBLE        49
PASSING SCORE   48
YOUR SCORE      49

CONGRATULATIONS - YOU PASSED

ANY REQUIRED TRAINING MATERIALS FOR FURTHER STUDY WILL BE PRINTED
FOR YOU.  SEE YOUR TRAINING OFFICIAL.

COMMAND?
```

Figure B-5. CII completion display when student passes test.

If he failed the module (Figure B-6), he was provided with diagnostics and prescriptives (Figure B-2) that were keyed to test questions and specific off-line instructional material.

```
MODULE TEST COMPLETED

POSSIBLE SCORE        49
PASSING SCORE         48
YOUR SCORE            45

SORRY - YOU DIDN'T MAKE IT THIS TIME

ANY REQUIRED TRAINING MATERIALS FOR FURTHER STUDY WILL BE PRINTED
FOR YOU.  SEE YOUR TRAINING OFFICIAL.

AFTER STUDYING THESE MATERIALS, YOU MAY RETAKE THE MODULE TEST.

COMMAND?
```

Figure B-6. CII completion display when student fails test.

These prescriptives were automatically recorded in the student's record in the data base. The examination procedure is shown in Figure B-7.

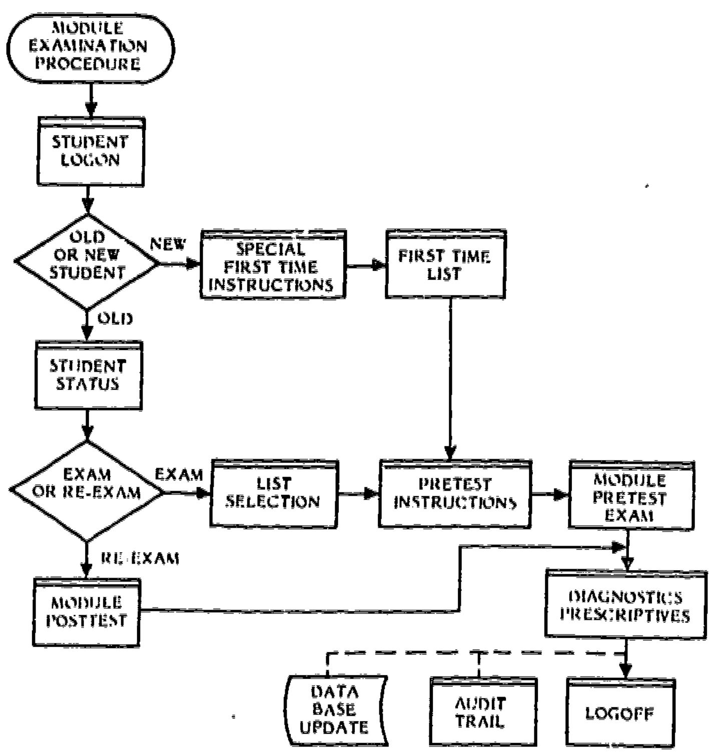

Figure B-7. CII examination procedure.

When the student felt that he had mastered the referenced prescriptive material (Figure B-2), he took the posttest, using the same general procedure as when taking the pretest. The posttest could be taken as many times as desired until it was successfully completed. At this time, the student received credit for the module, unless a practical test was also required; that is, actual operation of a piece of damage control equipment. The practical test was administered by a supervisor, and the student's score was inserted into the student data base via the teletype by the CII training official. If shipboard conditions did not permit the practical test to be administered, the student could still select a new module and proceed with the pretest. In this manner, he progressed through the CII modules until all were completed. Progress information was available to the student at any time. If he wished to receive this information, he selected the "DISP" command to view his record (Figure B-1) rather than proceeding to the next learning step.

At the end of each CII testing session, student progress information was updated and retained on a disk data file. Periodically, it was copied to cassette tape by the CII training official for off-line mass storage. CII student data files were deleted when a student graduated or dropped from the CII course (e.g., an enrolled student transfers off the ship).

APPENDIX C

GRIDLEY CII-SUPPORTED GENERAL DAMAGE CONTROL PQS QUALIFICATION PROCEDURE

GENERAL DAMAGE CONTROL PQS-2 QUALIFICATION PROCEDURE

All hands are required to complete General Damage Control Qualification (NAVEDTRA 43119-2AQ1), Section 2, 2401 Watchstation - General Damage Control, within six months of the reporting aboard. GRIDLEY utilizes the shipboard Computer Integrated Instruction (CII) system to prepare personnel to meet this requirement. The following checklist is provided for all personnel seeking General Damage Control PQS-2 qualifications through the CII system:

1.	REPORT ABOARD	Report aboard USS GRIDLEY (CG 21). Report to the ship's office for processing.
2.	RECEIVE CHECKLIST	Receive check-in sheet and this check list.
3.	SUBMIT PERSONNEL DATA	Submit personnel data information to the ship's office for the ship's automated Personnel Record System (PRS) and Shipboard Training Administration System (STAS).
4.	REPORT TO DIVISION OFFICER	Report to your Division Office (when directed). He will (1) scan your record and previous qualifications, (2) provide guidelines for advancement, initial ship qualifications and goals, (3) introduce you to your Divisional General Damage Control PQS Qualfication Petty Officer (DCQPO).
5.	REPORT TO DCA	Report to the Damage Control Assistant (DCA). He will: (1) describe the ship's General Damage Control PQS Qualification Program, (2) provide a brief overview of the shipboard Computer Integrated Instruction (CII) system, (3) hand out necessary General Damage Control PQS material and the qualifications card NAVEDTRA 43119-2AQ1.
6.	REPORT TO CII TRAINING OFFICIAL	Report to CII Training Official. Register in CII. Receive CII introduction brief. Obtain copy of "Introduction to CII."
7.	TAKE CII MODULE TEST	Select/take your first CII module test. If you pass, continue by taking additional module tests until a failure occurs. For each module test you pass you will receive module credit and PQS points. Upon failing a CII module test you will receive a computer generated prescription of lessonware and/or references to study from the CII Training Official. CII will also give you a Student Record Image summarizing modules passed and PQS points cummulated to date. This report also maintains a tally of PQS points earned from the "Watchstation" section of your PQS Qual Card. CII exams only test your knowledge of the "Theory" and "Systems of General Damage Control PQS. PQS points earned outside of CII can be entered manually by the CII Training Official.
8.	OBTAIN MODULE PRESCRIPTIVE	
9.	PICK-UP LESSONWARE	Pick up module lessonware from the CII Training Official.
10.	MAKE CII TESTING APPOINTMENT	Make your next CII testing appointment with the CII Training Official.
11.	REPORT TO DCQPO	Report to your Divisional General Damage Control PQS Qualifying Petty Officer (DCQPO). Show him your CII Student Progress Report. Have him sign off and update your PQS Qual Card. Only a command designed DCQPO can sign off for the "Theory" and "Systems" sections of the PQS Qual Card. Any qualified GDC watchstander may sign-off items in the "Watchstation" section of the PQS Qual Card. Keep your DCQPO informed of your next CII testing appointment date/time.
12.	STUDY LESSONWARE	Study your lessonware.
13.	COMPLETE "WATCHSTATION" PQS	Complete "Watchstation" PQS wherever practical. Remember to keep your DCQPO informed and your PQS Qual Card current. Have your DCQPO annotate on a recent CII Student Progress Report those "Watchstation" PQS points earned between CII testing appointments.
14.	KEEP CII TESTING APPOINTMENT	Keep your next CII testing appointment. If you cannot keep it, notify the CII Training Official and reschedule it. You should be able to complete at least one CII module test a week. CII monitors your progress and alerts you and your supervisor through a separate command report when you start to fall behind. It also singles out those individuals that are doing well. Your goal should be to get through the CII system and become PQS qualified as soon as possible.
15.	COMPLETE ALL MODULES AND PERFORMANCE TESTS	Continue to take the CII module tests and study any required lessonware until all modules are complete. Always bring and show your PQS Qual Card (or a recent CII Student Report Image annotated by your DCQPO) to the CII Training Official. He will update your cummulative PQS points earned outside CII on your next CII Student Report Image.

16. GRADUATE FROM CII	To graduate from the CII system present the FULL COMPLETED General Damage Control Qual Card NAVEDTRA 43119-2AQ1, pp. 3-8, to the CII Training Official. He will then record this completion milestone and issue you a final CII Student Report Image indicating "Graduation from CII."
17. REPORT TO YOUR SUPERVISOR	Report to your supervisor with your PQS Qual Card and final CII Student Progress Report. Your supervisor will review your PQS Qual Card to ensure all items are properly signed off and you actually possess knowledge of and proficiency on the Damage Control theory, systems, and equipment aboard this ship. Your supervisor will make a recommendation to your Division Officer regarding your qualifications on the PQS Qual Card (p. 1).
18. SEE YOUR DIVISION OFFICER AND DEPARTMENT HEAD	Your Division Officer and Department Head will further screen you and will make their appropriate recommendation concerning your qualifications on the PQS Qual Card.
19. SEE DCA	The Damage Control Assistant will give you your final screening prior to making his recommendation to the Commanding Officer on the PQS Qual Card. The DCA is particularly interested in and appreciative of your understanding of General Damage Control aboard this ship. He will give you an examination to test your overall knowledge. Be able to describe or demonstrate steps necessary to use and/or don DC equipment. The DCA will be looking to you for eventual assignments to repair and fire parties.
20. CO QUALIFICATION	Final Qualification comes from the Commanding Officer. He also is proud of your achievement and will not hesitate to ask questions about what you have learned and to listen to any recommendations you may have to improve the CII system of PQS qualifications.
21. SERVICE RECORD ENTRY	After your interview by the Commanding Officer your PQS Qual Card will be routed back to your division as an item for your training record and an appropriate service record entry will be initiated by the DCA.

APPENDIX D

GRIDLEY CII STUDENT QUESTIONNAIRE DATA

GRIDLEY STUDENT QUESTIONNAIRE DATA
(N = 138)

In response to the questions below, the following categorical results were obtained:

1. What aspects of CII/GDC did you particularly like?

   - Didn't like it, prefer conventional teaching methods (lecture, demonstrations) (10%)
   - Courseware (24%)
   - Computer testing and prescriptives (59%)
   - Computer student progress reporting (44%)
   - Ship's PQS system in general damage control (23%)
   - Training official assistance (5%)
   - DCPO proctor assistance (13%)
   - Other (11%)

2. Indicate any problems you had with the CII/GDC courseware (programmed text, sound-slide material, audio material, tests).

   - Had no significant problems with the courseware (60%)
   - Did not understand what was to be learned (i.e., training objectives were not clear) (6%)
   - Reading level of written instruction/tests too hard (1%)
   - Programmed text contained too much detail (6%)
   - Sound-on-slide material contained too much detail (1%)
   - Audio-only material contained too much detail (2%)
   - Programmed text too repetitive (5%)
   - Sound-on-slide material too repetitive (2%)
   - Audio-only material too repetitive (2%)
   - Sound-on-slide equipment too difficult to operate (2%)
   - Audio-only equipment too difficult to operate; did not prepare for practical "hands on" use of damage control equipment (please specify below which DC equipment not prepared for) (1%)

     - MK V gas mask (8%)
     - Oxygen breathing apparatus (OBA) (9%)
     - Twin Agent Fire Extinguishing System (TAS) (24%)

   - Could not find answers to questions missed during the module tests taken at the computer terminal (7%)
   - Lesson tests at end of programmed text did not help to pass the computer module tests (1%)
   - Other (11%)

3. Check any problems you had with the computer (terminal, printouts, tests).

   - Had no significant problems with the computer (58%)
   - Had difficulty getting the test program started on the CRT (12%)
   - Had difficulty using the CRT keyboard (2%)
   - Hard to read the CRT display (2%)
   - Some tests were too long (15%)
   - None of the test questions were numbered (3%)
   - Didn't know length of test before starting (5%)

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- Didn't know how to correct mistakes to answers made (4%)
- Awkward referring to test question exhibit booklet; difficult understanding computer printouts (please indicate below which printouts you had trouble with) (3%)

  - Module test results (2%)
  - Lesson prescriptives (4%)
  - PQS/course progress (2%)

- Other (7%)

4. Indicate any other factors (not specifically related to course material or computer aspects) that made the CII/GDC course difficult to complete.

   - There were no other factors which made the course difficult to complete (20%)
   - Computer malfunction (21%)
   - CRT malfunction (2%)
   - Sound-on-slide equipment malfunction (4%)
   - Audio-only equipment malfunction (1%)
   - CRT being used by other students (21%)
   - Sound-on-slide equipment being used by other students (7%)
   - Audio-only equipment being used by other students (3%)
   - Training official not available (5%)
   - CRT too hard to get to (6%)
   - Too busy doing other required shipboard duties (47%)
   - Lacked real incentive/motivation (20%)
   - Course not needed to complete General Damage Control PQS (4%)
   - Course not required by ship (0%)
   - Shipmates put course down (2%)
   - Kept forgetting to take next tests on student CRT (13%)
   - Course not supported by supervisor (2%)
   - Computer printout instruction/prescriptions not clear (0%)
   - Lessonware not available (2%)
   - Insufficient study time; study space limited (specify where limited below) (7%)

     - Berthing compartment (6%)
     - Work center (7%)
     - Weather deck (1%)

   - Study environment was too noisy (10%)
   - Study environment was too hot (2%)
   - Study environment had poor lighting (2%)
   - Study space was congested (14%)
   - Too many interruptions in study environment (21%)
   - No desk or chair in study environment (6%)
   - Other (8%)

5. For the following questions on GDC/PQS, please specify your answer with a check in the brackets provided. (A "?" indicates "I don't know" or "non-applicable" in your case.) Responses obtained from this question are provided in the following tabulation:

	Yes (%)	No (%)	? (%)
• Is this the first ship in which you have been required to qualify in General Damage Control PQS?	84	14	2
• Are you familiar with the PQS booklet NAVEDTRA 43119-2A, "Personnel Qualification Standard for Damage Control, Qualification Section 2, General Damage Control?"	57	33	10
• Is your General Damage Control PQS progress charted in your divisional spaces?	44	36	20
• Is the chart updated weekly?	25	41	34
• Do you know the divisional DCPO in your division?	91	8	1
• Do you know who the General Damage Control PQS qualifying petty officer is in your division?	74	23	3
• What is his name?	74	23	3
• Is he General DC PQS qualified?	59	1	40
• Is he the same person as the DCPO?	39	31	30
• Did the shipboard training program CII course help you to complete the theory and systems requirements for your General Damage Control PQS qualifications?	59	20	21
• Did your divisional DCPO or PQS qualifying petty officer ever help you with your CII course when you needed assistance?	44	39	17
• Do you intend to reenlist when your present enlistment expires?	19	59	21

6. Lastly, how would you rate the relative importance of the following where 3 = Not really important, 2 = Fairly important, 1 = Very important, and 0 = I'm indifferent.

	0 (%)	1 (%)	2 (%)	3 (%)
• Knowledge of General Damage Control to your primary duty assignment aboard this ship.	5	44	26	25
• Knowledge of General Damage Control to you personally.	6	40	43	11
• NBC defense.	6	56	27	11
• First aid and rescue.	2	76	16	6

	0 (%)	1 (%)	2 (%)	3 (%)
• Safety precautions	2	67	21	10
• Damage control organization.	9	44	34	13
• Damage control communications.	5	50	32	13
• Firemain system.	3	50	32	13
• Drainage system.	6	43	29	22
• Shipboard ventilation.	4	47	29	20
• Fixed damage control equipment.	2	50	30	18

APPENDIX E

STAS FILE MANAGEMENT SYSTEM APPLICATIONS

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STAS FILE MANAGEMENT SYSTEM APPLICATIONS

Personnel Administration

Personnel Record System (PRS)

The GRIDLEY Personnel Record System (PRS) consisted of an 85-item enlisted-personnel data base and approximately 20 print programs that were developed by GRIDLEY managers as the need arose. The data base was maintained initially by NAVPERSRANDCEN and the ship's assigned DPC, and later was maintained entirely by ship's office personnel.

PRS was used extensively and continuously by GRIDLEY. Personnel rosters and lists, sorted by specific data-base elements, not only saved manual sorting and typing time, but also provided useful summary information for many diverse users who heretofore had either sparse or outdated distribution of such information. For example, PRS provided:

1. Inport duty-section rosters and qualification information for personnel responsible for watch assignments.

2. Qualification information for personnel tasked to train and qualify watchstanders.

3. Leave and duty status for workload planning.

4. Up-to-date lifeboat assignments for personnel safety at sea.

5. Filled/empty bunk lists to facilitate new personnel berthing.

6. Accurate and timely muster reports for legal and personnel tracking purposes.

7. Personnel locator rosters for the quarterdeck and the ship's telephone switchboard station.

8. Partially filled out Combined Federal Campaign (CFC) contribution forms to accommodate allotment donations.

9. Ethnic background summary and statistical information for external reporting on equal opportunity.

10. Blood-type and shot-record information for use by the Hospital Corpsman.

11. Rate, PRD/EAOS, and enlistment status information for use by the ship's Career Counselor.

Public Affairs Officer File

The ship's Public Affairs Officer (PAO) File contained a name and address data base to facilitate maintenance and accuracy of dependents' home addresses. Only the PAO or his assigned assistant had access to the PAO data base. Mailing of general public correspondence to dependents, such as Familigrams, was accelerated by a print program that printed the PAO address labels in ZIP code order. Use of these computer-generated address labels saved GRIDLEY an estimated 2 man-days of typing and mail sorting for each public mailing.

Operations

Employment Schedule

This file contained two data bases to cover both major and concurrent employment schedules of GRIDLEY and selected ships. A new file was generated at the beginning of each quarter; past file data bases were stored on cassette tape for historical purposes. GRIDLEY used this employment-schedule file during the ship's 1976 deployment to facilitate documenting operating schedule changes, and to track other task force and ship replenishment positions. On several occasions, GRIDLEY could easily reconstruct past employment (e.g., number of days at sea) using the employment history tapes. Data were maintained by the assigned DPC, using microfilm or naval message-source inputs.

Publication Inventory System

This application contained data bases to manage the inventory and accountability of over 500 publications on weapons, CIC, and intelligence. Publication inventory printouts provided GRIDLEY with an accurate and up-to-date publication locator and custodian record. Top-secret inventory listings were administered in accordance with proper ADP security procedures. Data bases were maintained by the assigned publication custodians.

Material Maintenance

Deficiency Logs

Automated work-center-deficiency logs were used to track the status of material, administrative, and training deficiencies for each work center of the ship. The logs also contained Commanding Officer Material Zone Inspection results, which could be printed and sorted out by compartment number. Job completion overdue reports, work projection reports (e.g., 1 week, 1 month), work history reports, and overall discrepancy listings by work center were available.

Usage of this application declined in work centers that lacked personnel to maintain their specific work-center data bases.

IMA Job Status

During deployment, GRIDLEY's repair and fabrication jobs were accomplished by several tenders and repair facilities ashore. An automated file was established, using FMS to facilitate monitoring of Intermediate Maintenance Activity (IMA) and depot work during regular and concurrent availabilities. This file simplified the bookkeeping necessary to track the progress of hundreds of jobs located within the many codes or shops of a tender or repair depot. GRIDLEY found that the accuracy and timeliness of the ship's IMA job status were more dependable than when provided by the repair activity. In one case, an IMA used GRIDLEY's automated status as input to the IMA's computer.

Preoverhaul Test and Inspection (POT&I)

Six months prior to entering regular yard overhaul, GRIDLEY underwent an extensive, self-administered material inspection to identify all necessary industrial and ship's force work items for the upcoming overhaul. Over 1500 work items were found and stored in an FMS data file, using an abbreviated automated discrepancy log format. This file subsequently became the ship's Preoverhaul Test and Inspection (POT&I) data base and provided GRIDLEY with planning and negotiating aid in preparation for regular overhaul.

General Purpose Electronic Test Equipment (GPETE)

GRIDLEY uses over 600 pieces of general-purpose electronic test equipment (GPETE), which have to be kept inventoried, calibrated, repaired or replaced, and custody-managed for ship-wide distribution and control. To manually manage this GPETE system, a dedicated Electronics Technician (ET) was required. On automating the GPETE system, using FMS, GRIDLEY improved the quality of the GPETE inventory, automatically monitored GPETE calibration due dates, and promulgated computer printed GPETE out-of-calibration reports and turn-in requests. GRIDLEY claims that the GPETE file management application not only speeded the elimination of a backlog of out-of-calibration and on-order replacement GPETE equipage, but also release the ET custodian to perform essential electronic maintenance. All GPETE record maintenance subsequently was assumed by the ship's Electronic Material officer on an as-needed basis.

Valve Maintenance and Gauge Calibration

Like electronic test equipment, valves and gauges are numerous and require periodic maintenance and/or calibration. Automating the inventory, calibration, repair, and accountability process for valves and gauges was in the planning stages when GRIDLEY entered regular overhaul in early 1978.

Supply

Material Requisition Status

As GRIDLEY entered overhaul in early 1978, a need arose to monitor outstanding material requisition status by department and work centers to facilitate Ship's Force Overhaul Maintenance System (SFOMS) job scheduling. A supply-requisition-status data base was established and an initial preformatted report was developed and promulgated, using FMS, within 1 week from the time a requirement was identified. Use of FMS saved approximately $10,000, the cost of a contract to acquire and maintain the same data for the duration of the overhaul period. The data base was to be maintained by a ship's storekeeper (SK) using initial requisition source documents, status cards, and custody receipts.

APPENDIX F

ASIMS EQUIPMENT RELIABILITY AND MAINTENANCE HISTORY

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ASIMS EQUIPMENT RELIABILITY AND MAINTENANCE HISTORY

During the evaluation period, it was determined that ASIMS could function adequately aboard GRIDLEY with a minimum of component equipment; that is, a central processing unit, a line printer (80 or 132 character), a teletype control console, and two CRT display terminals. Assuming that total ASIMS reliability would depend on the availability of such a nucleus, any estimate of total ASIMS reliability should not exceed the reliability factor of the weakest component of the nucleus group. Consequently, a reliability factor of r = .928, the component reliability factor of the central processing unit (Table 5 in text), was selected as a gross estimate for a total ASIMS reliability factor.

ASIMS performed well underway, in rough seas, during periods of heavy vibration (e.g., gun shots, missile firing, and backing engines), in variable temperatures (55° to 85°), and in the presence of radar radiation on the 05 level of GRIDLEY. It is noteworthy that the ASIMS hardware was originally in use in USS DALHGREN from 1973 to 1975 and at NAVPERSRANDCEN from 1975 to 1976 before being used aboard GRIDLEY. At the end of the evaluation period in late 1977, the minicomputer and peripherals were all operational and functioning.

While under maintenance contract with Data General Corporation, most ASIMS repairs were accomplished on board GRIDLEY during a 1-day maintenance visit. Maintenance usually consisted of replacing parts and making minor adjustments to equipment components. A disk drive unit, a cassette tape unit, and a CRT display terminal, however, had to be removed from GRIDLEY for depot repair by Data General Corporation. The system operator performed some preventive maintenance, such as cleaning disk drive read/write heads and replacing deteriorating line-printer control tapes. Equipment downtime was attributed, in part, to waiting on the contractor maintenance technicians, either because they were servicing a higher priority commercial client or could not reach the ship because it was at sea or otherwise inaccesssible.

A detailed summary of the reliability and maintenance history of each ASIMS component is contained in the following paragraphs.

Central Processing Unit (CPU)

The CPU had a reliability of .928 and a downtime percentage of approximately 7 percent. CPU malfunctions were limited to one bad 8K core-memory board, a power-supply failure, and minor problems with various peripheral I/O circuit boards. All repairs were made on board ship by Data General maintenance technicians and involved only replacement of parts. Approximately 5 percent (25 days) of CPU downtime was attributed to waiting for a maintenance technician to be summoned and transported to GRIDLEY while the ship was deployed in the Western Pacific during 1976. Several times the CPU became inoperative due to dirty read/write heads on the disk drive units or to faulty I/O-device connections (e.g., loose or shorted wire to a remote video-display terminal). These problems were corrected by the system operators as they occurred.

Disk Drive Units (2)

One disk drive unit had a reliability of .998 (1% downtime); and the other, .954 (5% downtime). Significant malfunctions were:

1. Damaged logic-control board caused by electrical arcing on the board. Unit was replaced with a factory spare and repaired at a Data General repair depot in about 20 days.

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2. Phasing and sequence timing difficulty occurred twice and was repaired with minor adjustments by Data General maintenance technicians.

3. Dirty read/write heads, which caused parity errors and CPU shutdown, occurred twice. Heads were cleaned by system operators using an alcohol-base cleaning fluid and lint-free tissue. This became a regular semiannual PMS check. Disks collected dirt during initial system installation in 1976 due to aluminum welding work in the computer room. Smoking also contributed to dirty read/write heads and was prohibited in the computer space in early 1977.

4. Several fuses were blown and replaced.

Cassette Tape Units (CTU)

There were two cassette tape units, each containing three independent cassette tape drives. One CTU had a reliability of .88 (12% downtime); and the other, .366 (63% downtime). The CTUs were of poor quality and had a high casualty rate. One CTU was eventually surveyed "beyond economical repair" in early 1977 after 10 months of intermittent operation. In the other CTU, either one or two of the three cassette tape drives was inoperative. Most problems with the CTUs involved worn or broken parts, such as bushings, brakes, fans, chips, diodes, and transistors. These units were generally not repairable on board ship due to inexperience by the maintenance technicians on CTU repairs and/or lack of parts. When a CTU did operate, it required frequent adjustments and cleaning by the system operators.

The nonavailability of the cassette tape units or drives resulted in an inability by the system operators to build backup files, maintain historical data, conduct diagnostics, and add or transfer data to and from the disks. Extra disk space had to be allotted to perform these CTU functions. Even when the CTUs were operating, system operators were not encouraged to use the cassette tapes for data storage because of their limited capacity (40K words) and long run time (up to 10 minutes).

Teletype Computer Console (TTY)

The TTY had a reliability of .951 (5% downtime). The TTY was rebuilt in 1975 by NAVPERSRANDCEN because it had been damaged by spray paint while installed aboard DAHLGREN. The paper tape punch-reader never operated properly while on board GRIDLEY. A nylon gear had to be replaced in October 1976. Minor lubrication and PMS adjustments were occasionally performed by the Data General maintenance technicians.

Line Printer (132 Character)

The 132-character line printer had a reliability of .820 (18% downtime). This printer experienced several malfunctions:

1. On six occasions, control and logic circuit cards had to be replaced or repaired due to possible equipment overload. On-site soldering or chip repairs were made by Data General maintenance technicians or by a system operator receiving directions from such technicians via telephone.

2. Four carriage-control milar tape ribbons, which control printer paper paging, had to be replaced and/or realigned. This repair was done by either a maintenance technician or a system operator.

3. Four printer hammers had to be replaced by a maintenance technician.

4. A washer dropped into the printer while civilian contractor personnel were installing equipment above the printer and destroyed two magnetic strips and five printer hammers. Maintenance technicians made all necessary repairs.

5. A rubber printing-drum belt broke and was replaced by a maintenance technician.

6. Other minor problems involved adjusting the drum timing ring, repairing a magnetic backing strip, and replacing a deteriorated wiring harness and worn wires. These repairs were accomplished by a maintenance technician.

Line Printer (80 Character)

The 80-character line printer had a reliability of 1.000 (0% downtime). This printer was rebuilt in 1975 by NAVPERSRANDCEN because of improper storage while on DAHLGREN. While on GRIDLEY it was used as a backup printer and operated about 18 percent of the time. No PMS nor maintenance of any type was performed on this printer. A gravity switch, which caused the printer to be turned off during heavy rolling at sea, was taped by the system operator to prevent printer shut-off.

Card Reader

The card reader had a reliability of 1.000 (0% downtime) and was used less than 20 times to read cards. An operating software problem, which was not resolved until mid-1977, caused data to be garbled when the unit was used. Maintenance personnel experienced difficulty with blown fuses while performing preventive maintenance. This problem was eliminated by using "slow-blow" fuses as specified by the manufacturer.

Video-Display Terminals (CRT)

There were four CRTs in the computer system on GRIDLEY. Since the CRTs were interchangeable, their reliability was 1.000, .998, .949, and 485 (0%, 1%, 5%, and 56% downtime), respectively. For example, at least one of the CRTs was inoperative 56 percent of the time. CRT malfunctions included a faulty shift key, dirty or corroded aluminum contacts, bad I/O boards, faulty key-board characters, and loose or shorted CRT connector plugs. Even if a malfunction was considered minor or intermittent, such as a bad character display for one character, the CRT was logged out of commission. The CRT with the bad shift key took 150 days to be repaired at a Data General repair depot.